

# **AFE 76s2 Report**

## **Derivation of Radar Altimeter Interference Tolerance Masks**

**Volume I: Introduction,  
Test Procedures, and  
Fundamental Test Results**

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### 3.2.3 5000+ Feet AGL

#### 3.2.3.1 Summary

Table 3-16: UC1 5000'+ AGL Test Conditions

Source	Rationale	Signal Type	Characteristics	Setting
VSG	5G Fundamental OOB	OFDM	100 MHz TM1.1 centered at 3750 MHz, 3850 MHz, 3930 MHz	Power Sweep
VCOs 1-2	Own-ship multiplex installation	FMCW	CF: 4300 MHz BW/Sweep Rate per AUT	ON
VCOs 3-16	WCLS – other aircraft	FMCW		OFF

Table 3-17: UC1 5000'+ AGL OOB Fundamental Emissions Break Points

Altimeter	AGL	5000+ ft, Own-Ship VCOs											
		3750 MHz				3850 MHz				3930 MHz			
		ME	1%	99%	NCD	ME	1%	99%	NCD	ME	1%	99%	NCD
F	5000 ft	-27 dBm	-25 dBm	NB	-24 dBm	-28 dBm	-27 dBm	NB	-26 dBm	-30 dBm	-28 dBm	NB	-28 dBm
L	5000 ft	NB	-9 dBm	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB
T	7000 ft	NB*	NB*	NB	NB	-7 dBm*	-6 dBm	NB	-4 dBm	-14 dBm	-12 dBm	NB	-9 dBm
X	5000 ft	-11 dBm	-10 dBm	NB	-7 dBm	-26 dBm	-16 dBm	NB	-14 dBm	-24 dBm	-23 dBm	NB	-20 dBm
Y	5000 ft	-23 dBm	-23 dBm	NB	-25 dBm	-24 dBm	-19 dBm	NB	-25 dBm	-25 dBm	-25 dBm	NB	-26 dBm
ITM		-33 dBm				-34 dBm				-36 dBm			
PSD		-53 dBm/MHz				-54 dBm/MHz				-56 dBm/MHz			

\* – Indicates engineering judgement was applied to determine break point

### 3.2.3.2 Altimeter F

Table 3-18: UC1 RA-F 5000' AGL OOB Fundamental Emissions Break Point Summary

Center Frequency	Plot	Comments
<b>3750 MHz</b>	Time History Figure 3-76	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-77 Figure 3-78	Mean error exceeds the $\pm 0.5\%$ criterion threshold near -27 dBm. 1 <sup>st</sup> percentile measured height is less than the -2% criterion threshold near -25 dBm. An NCD occurs near -24 dBm.
<b>3850 MHz</b>	Time History Figure 3-79	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-80 Figure 3-81	Mean error exceeds the $\pm 0.5\%$ criterion threshold near -28 dBm. 1 <sup>st</sup> percentile measured height is less than the -2% criterion threshold near -27 dBm. An NCD occurs near -26 dBm.
<b>3930 MHz</b>	Time History Figure 3-82	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-83 Figure 3-84	Mean error exceeds the $\pm 0.5\%$ criterion threshold at -30 dBm. An NCD occurs at -28 dBm. 1 <sup>st</sup> percentile measured height is less than the -2% criterion threshold at -28 dBm.

Center Frequency = 3750 MHz

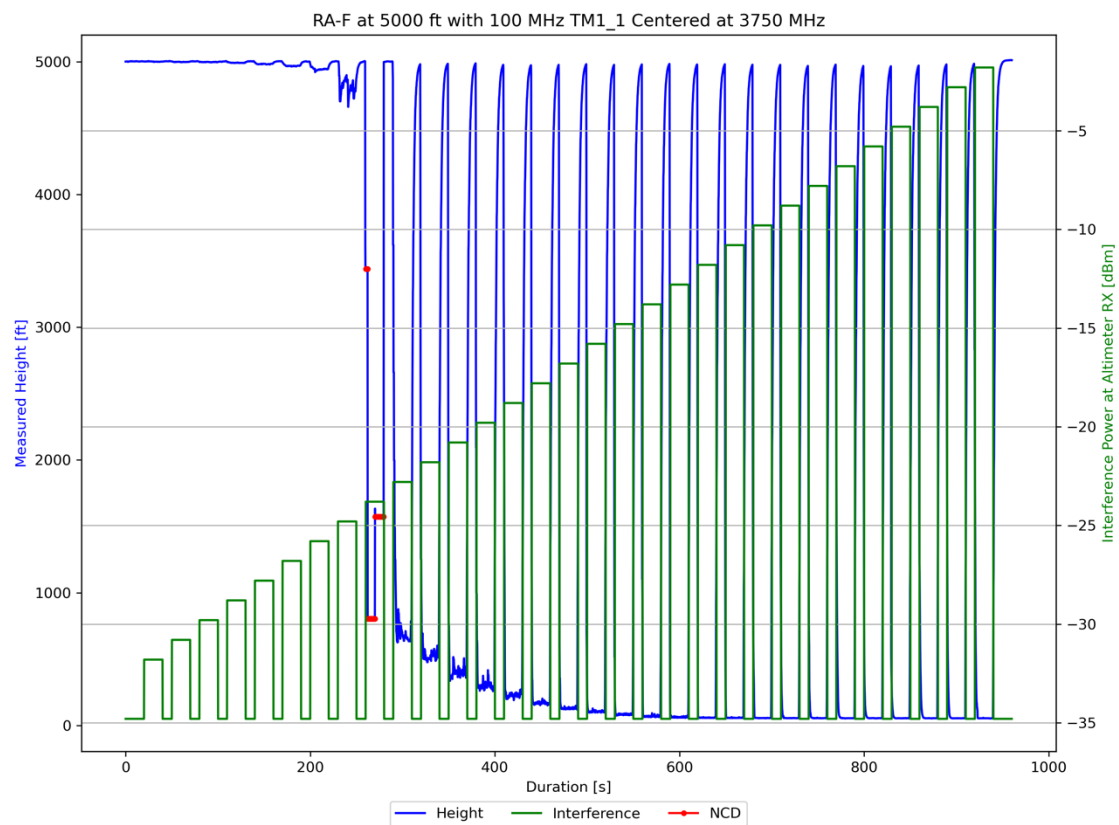


Figure 3-76: UC1 RA-F 5000' AGL Time History with TM1.1 at 3750 MHz



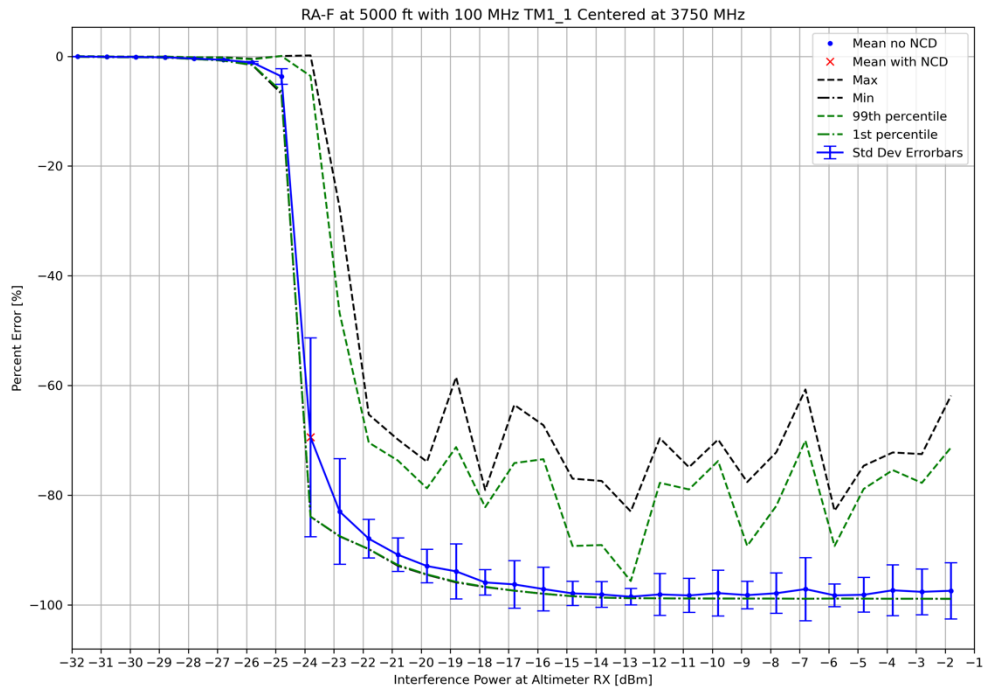


Figure 3-77: UC1 RA-F 5000' AGL Statistics with TM1.1 at 3750 MHz – Zoomed Out

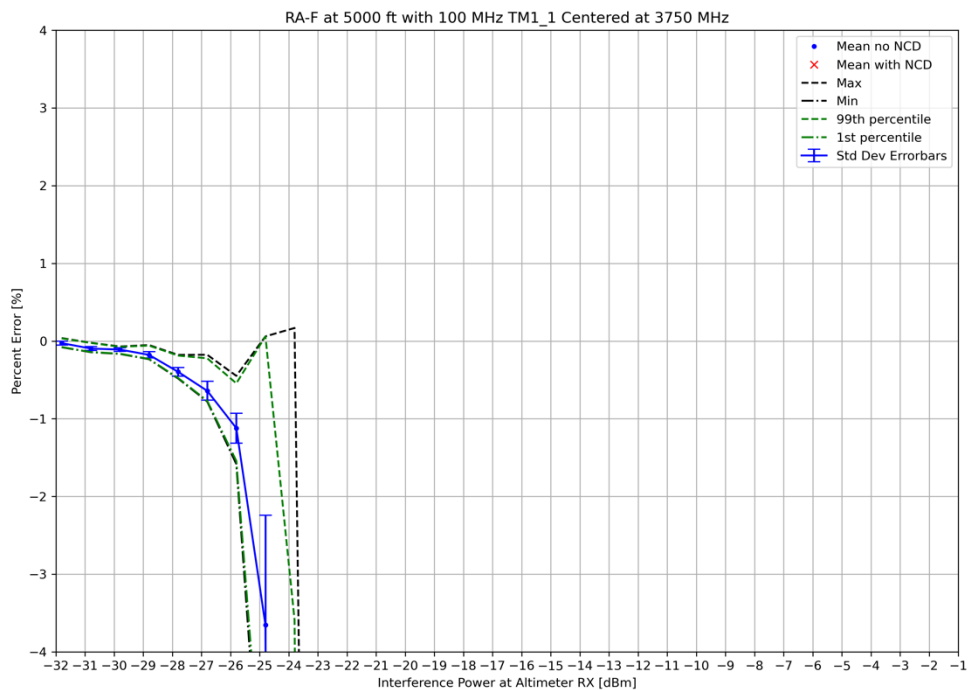


Figure 3-78: UC1 RA-F 5000' AGL Statistics with TM1.1 at 3750 MHz – Zoomed In

Center Frequency = 3850 MHz

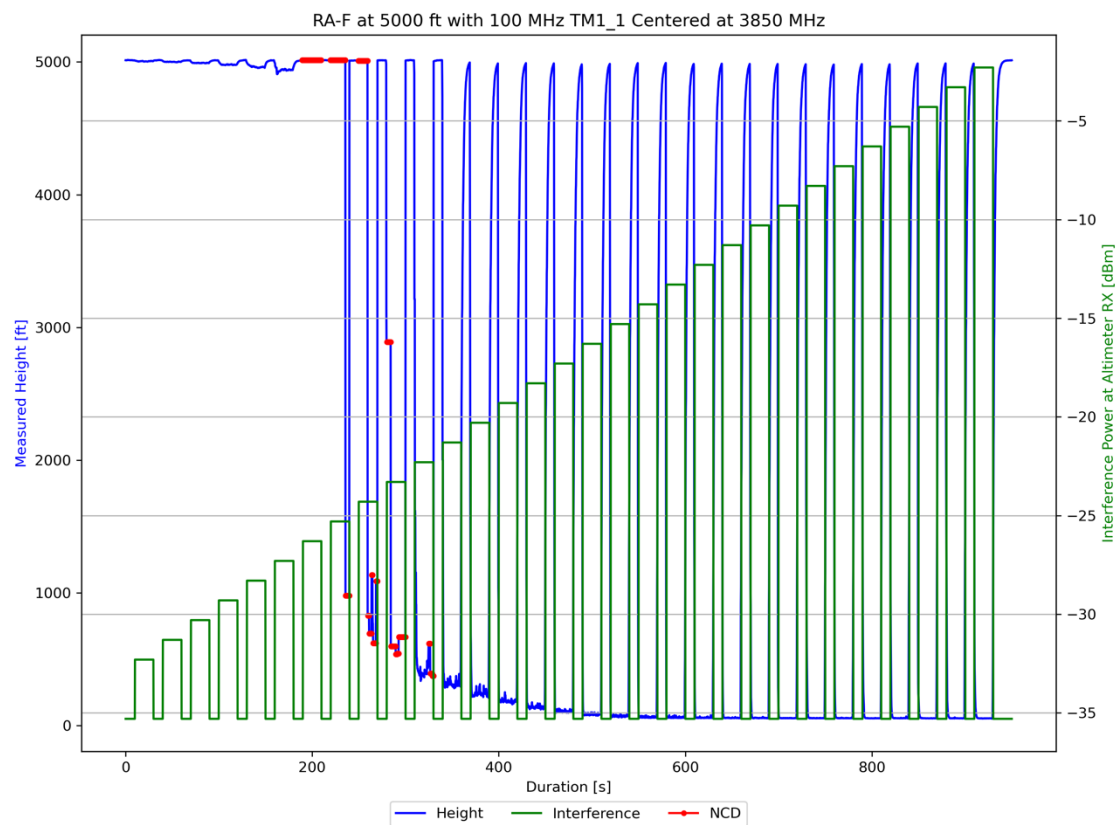


Figure 3-79: UC1 RA-F 5000' AGL Time History with TM1.1 at 3850 MHz

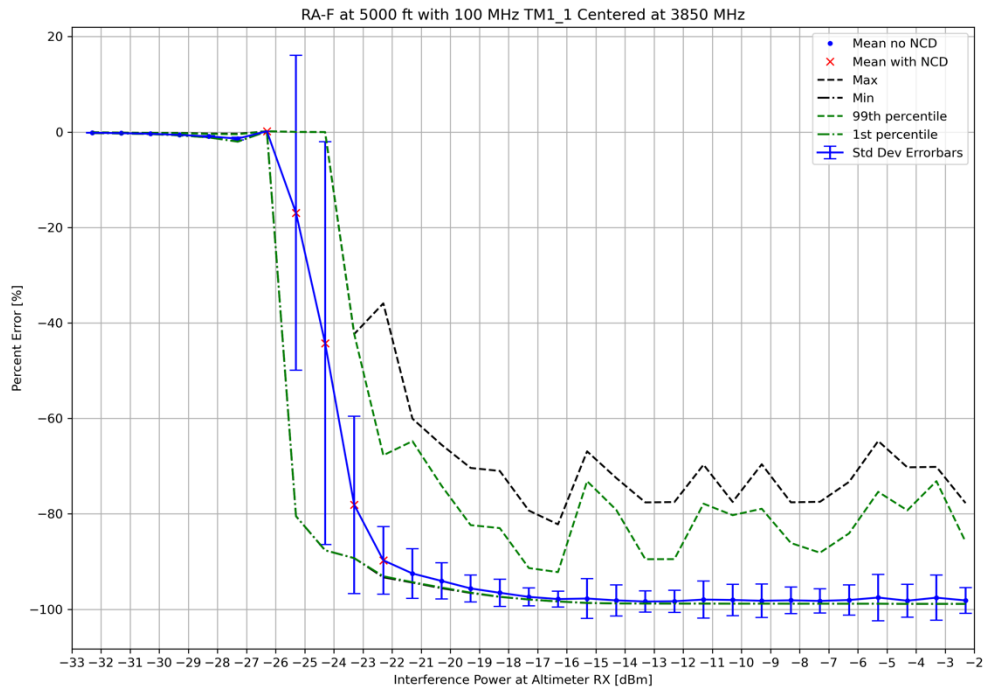


Figure 3-80: UC1 RA-F 5000' AGL Statistics with TM1.1 at 3850 MHz – Zoomed Out

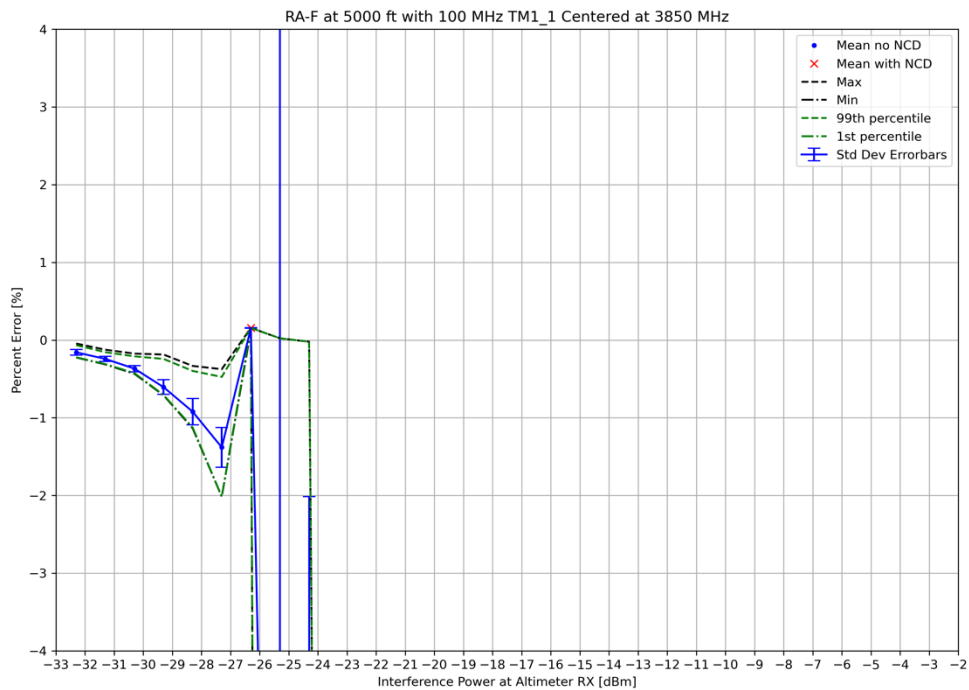


Figure 3-81: UC1 RA-F 5000' AGL Statistics with TM1.1 at 3850 MHz – Zoomed In

Center Frequency = 3930 MHz

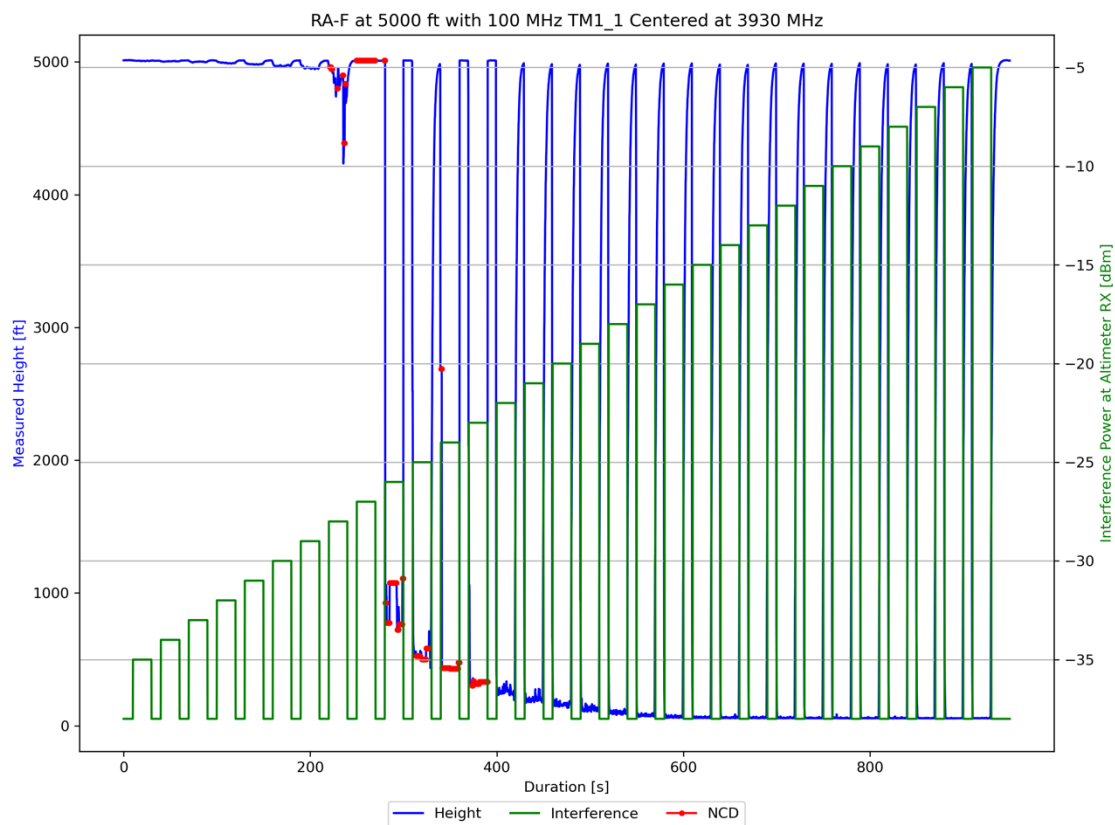


Figure 3-82: UC1 RA-F 5000' AGL Time History with TM1.1 at 3930 MHz

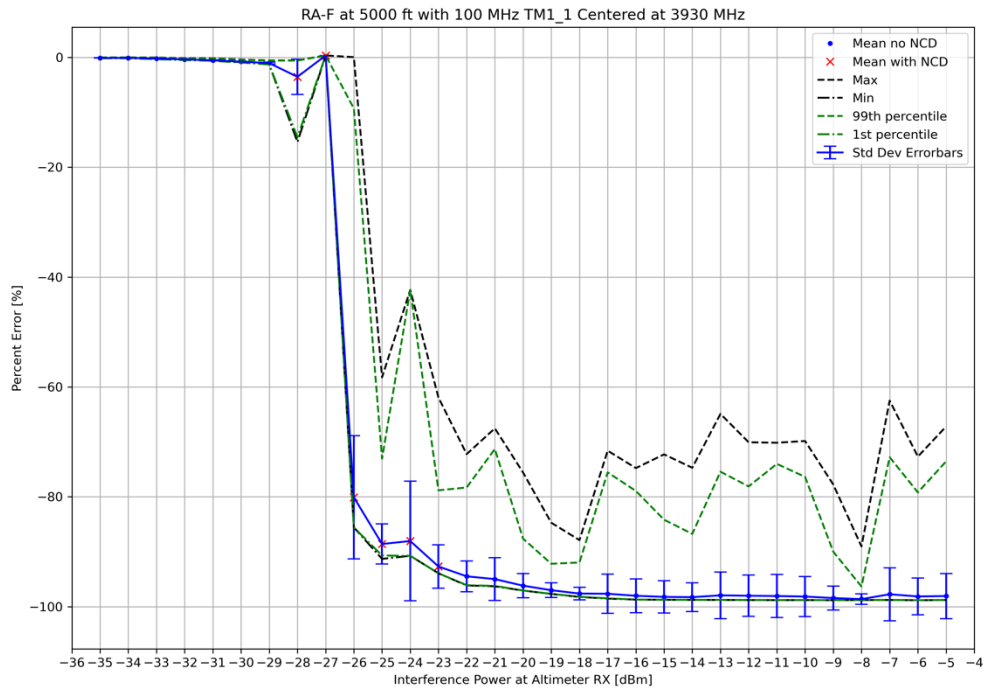


Figure 3-83: UC1 RA-F 5000' AGL Statistics with TM1.1 at 3930 MHz – Zoomed Out

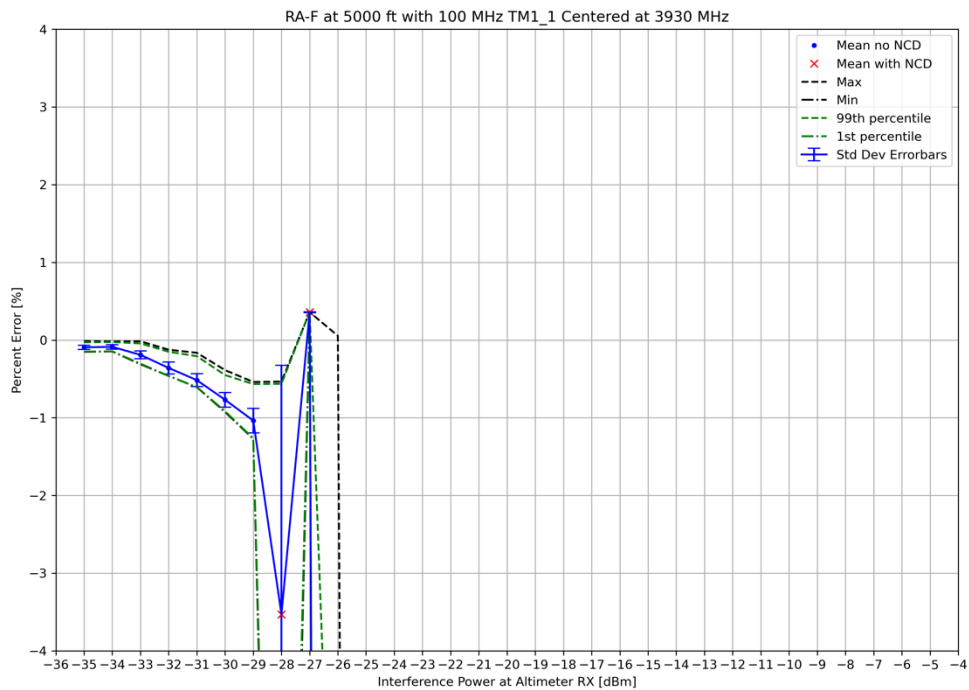


Figure 3-84: UC1 RA-F 5000' AGL Statistics with TM1.1 at 3930 MHz – Zoomed In

### 3.2.3.3 Altimeter L

*Table 3-19: UC1 RA-L 5000' AGL OOB Fundamental Emissions Break Point Summary*

Center Frequency	Plot	Comments
<b>3750 MHz</b>	Time History Figure 3-85	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-86	1 <sup>st</sup> percentile measured height is less than the -2% criterion threshold near -9 dBm.
<b>3850 MHz</b>	Time History Figure 3-87	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-88	No break observed.
<b>3930 MHz</b>	Time History Figure 3-89	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-90	No break observed.

Center Frequency = 3750 MHz

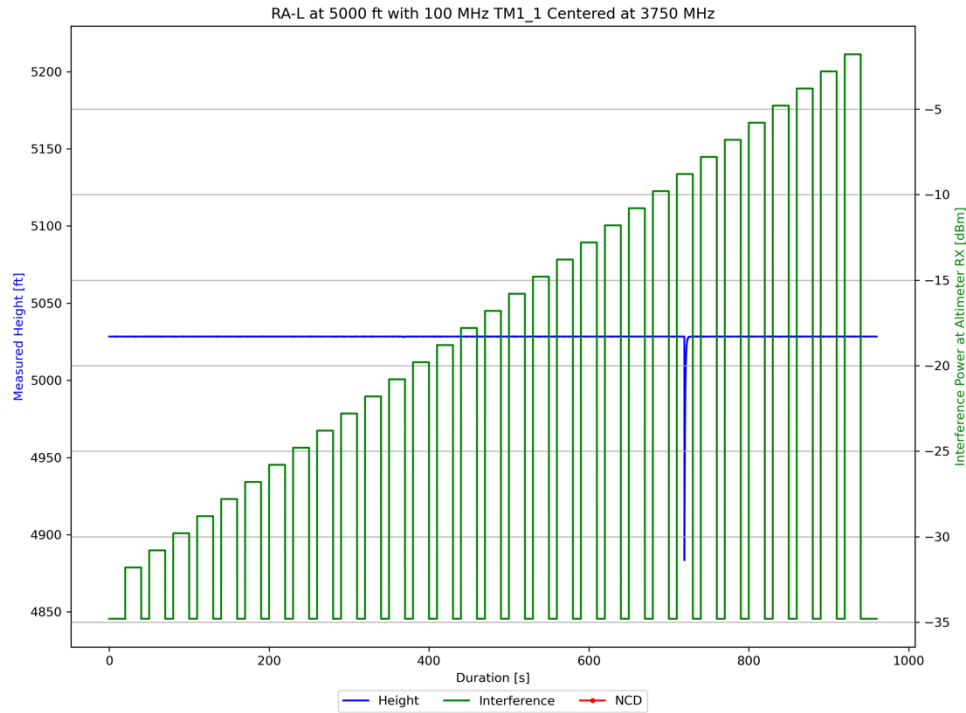


Figure 3-85: UC1 RA-L 5000' AGL Time History with TM1.1 at 3750 MHz

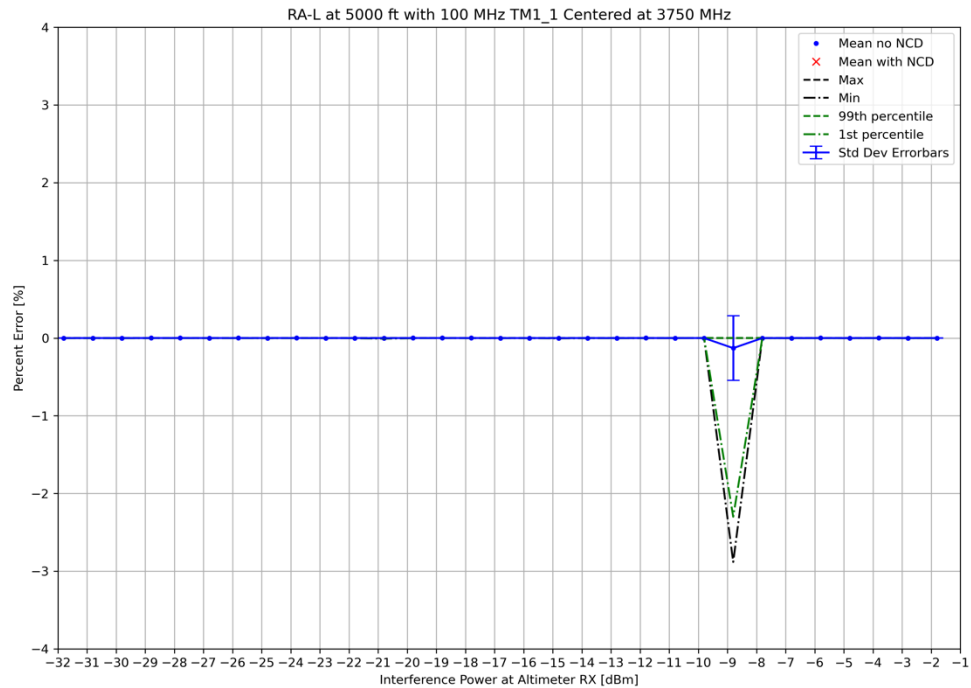


Figure 3-86: UC1 RA-L 5000' AGL Statistics with TM1.1 at 3750 MHz

Center Frequency = 3850 MHz

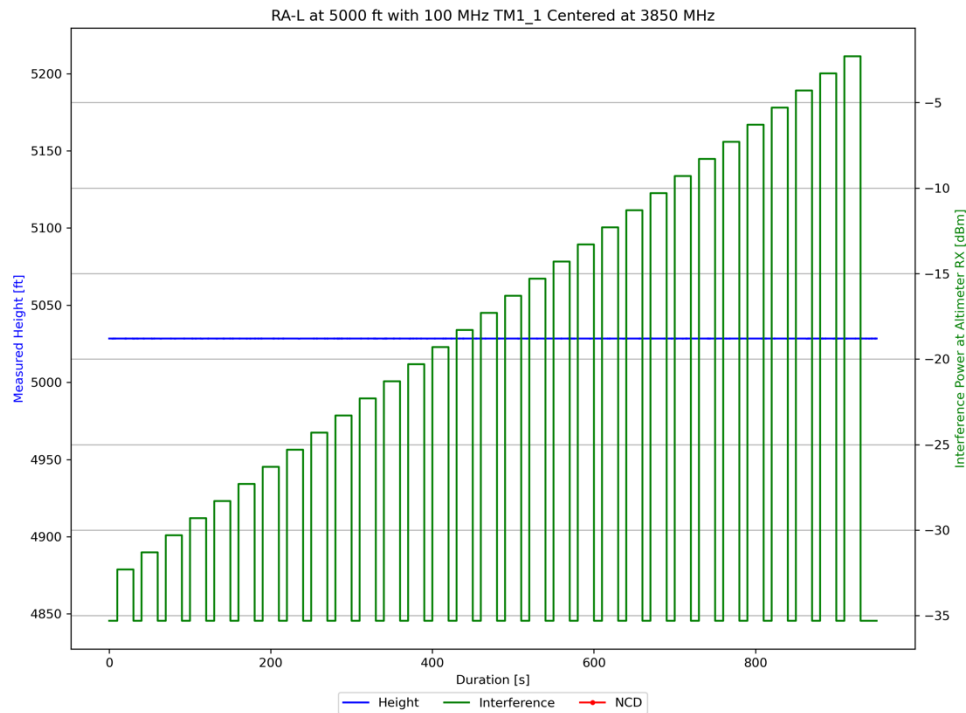


Figure 3-87: UC1 RA-L 5000' AGL Time History with TM1.1 at 3850 MHz

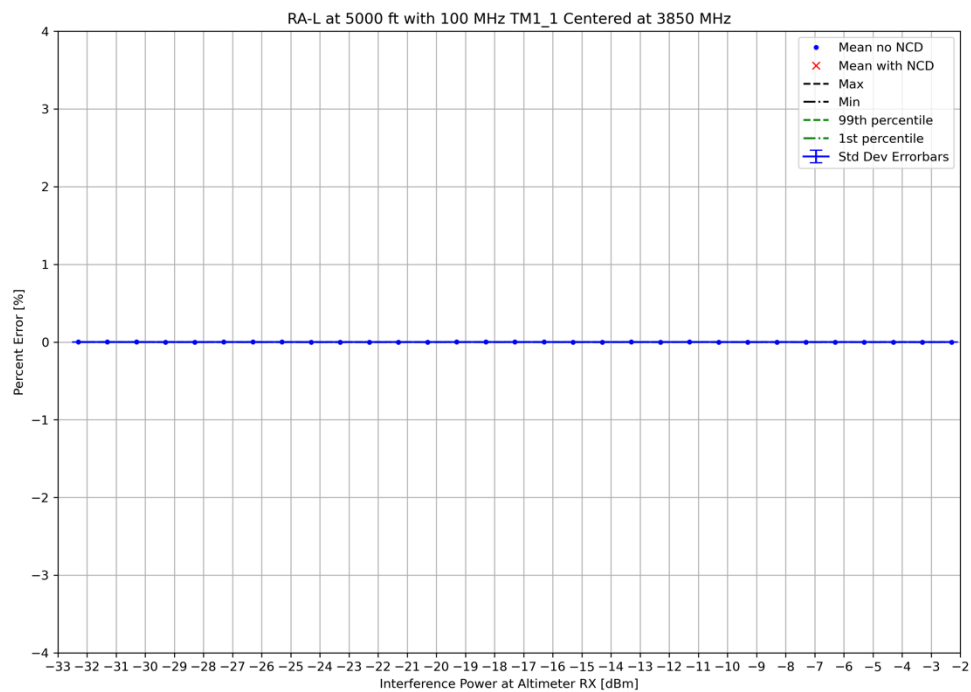


Figure 3-88: UC1 RA-L 5000' AGL Statistics with TM1.1 at 3850 MHz



Center Frequency = 3930 MHz

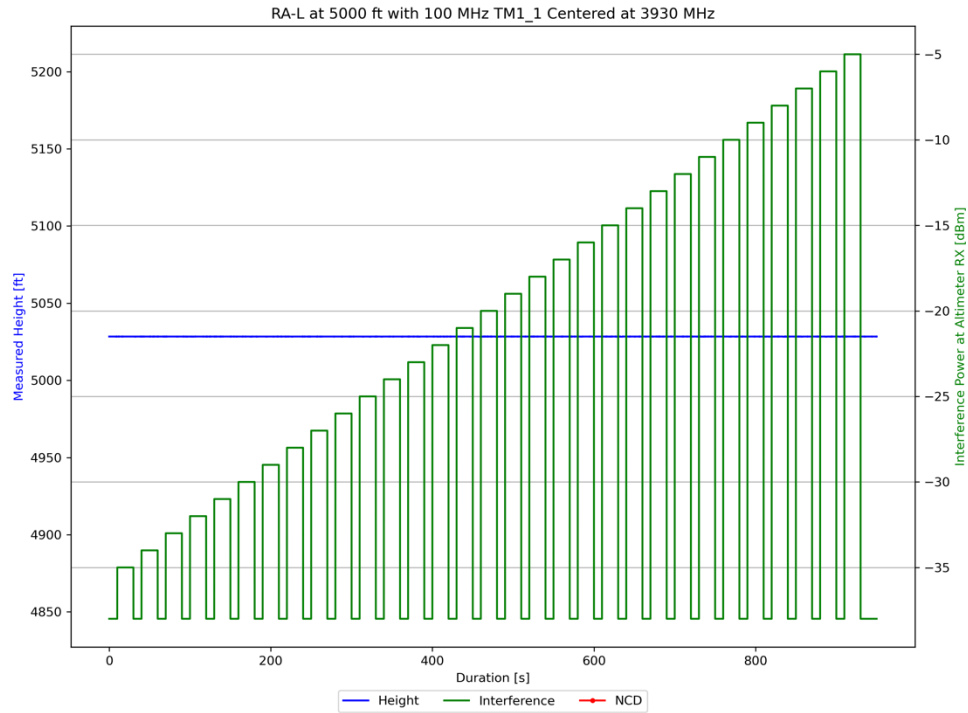


Figure 3-89: UC1 RA-L 5000' AGL Time History with TM1.1 at 3930 MHz

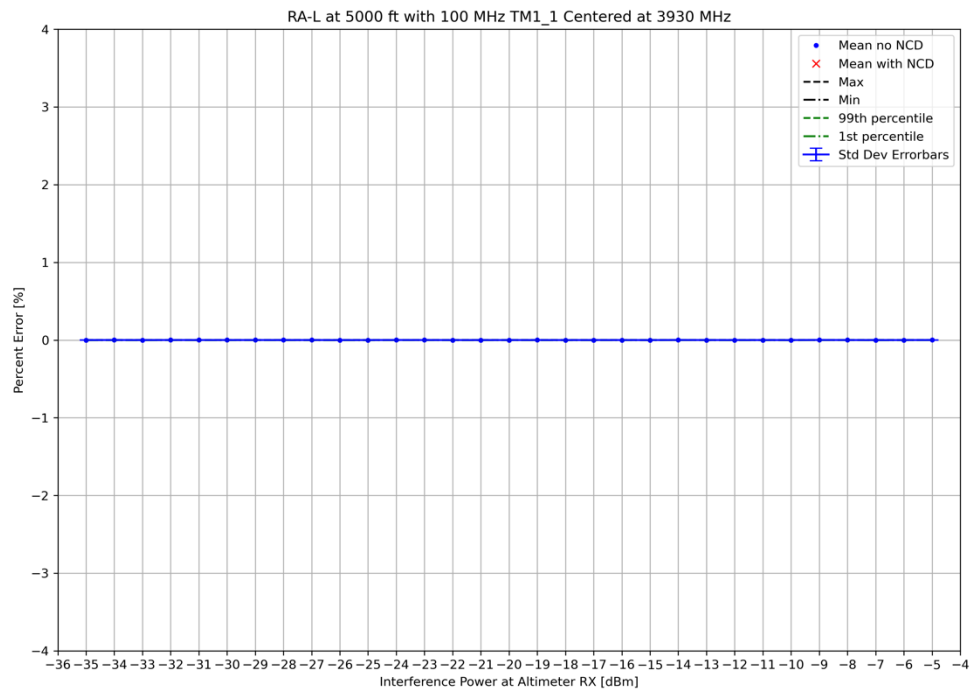


Figure 3-90: UC1 RA-L 5000' AGL Statistics with TM1.1 at 3930 MHz

### 3.2.3.4 Altimeter T

Table 3-20: UC1 RA-T 7000' AGL OOB Fundamental Emissions Break Point Summary

Center Frequency	Plot	Comments
<b>3750 MHz</b>	Time History Figure 3-91	Shows magnitude of change in measured height over time for increasing interference power levels.  This plot also shows a 500-point moving average in magenta to illustrate longer time scale changes in the measured height that are not correlated with the 5G RF interference OFF/ON periods. These changes are largely removed from the calculation of the statistics by the differential measurement described in Section 2.3.3 and as shown in Figure 3-92.
	Statistics Figure 3-92	The mean error and 1 <sup>st</sup> percentile criteria are exceeded at several points in the figure. However, subject matter experts agreed that given the behavior observed in the time history plot and the fluctuations in this plot, these exceedances cannot be definitively attributed to 5G RF interference and engineering judgement should be applied to conclude that there was no break in this power sweep.
<b>3850 MHz</b>	Time History Figure 3-93	Shows magnitude of change in measured height over time for increasing interference power levels.  The magenta line is a 500-point moving average height.
	Statistics Figure 3-94 Figure 3-95	Mean error exceeds the $\pm 0.5\%$ criterion threshold near -11 dBm and again near -7 dBm. Subject matter experts applied engineering judgement to determine that given the fluctuation in the time history behavior, -7 dBm is a more accurate indication of the break point.  1 <sup>st</sup> percentile measured height is less than the -2% criterion threshold near -6 dBm.  An NCD occurs near -4 dBm.
<b>3930 MHz</b>	Time History Figure 3-96	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-97	Mean error exceeds the $\pm 0.5\%$ criterion threshold at -14 dBm.  1 <sup>st</sup> percentile measured height is less than the -2% criterion threshold at -12 dBm.  An NCD occurs at -9 dBm.

Center Frequency = 3750 MHz

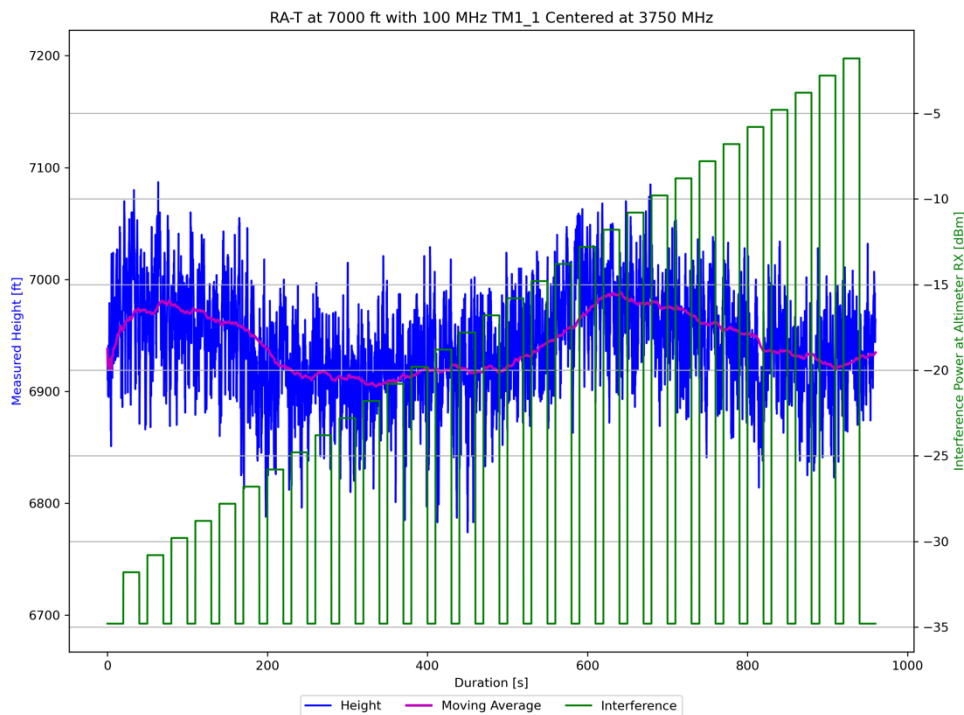


Figure 3-91: UC1 RA-T 7000' AGL Time History with TM1.1 at 3750 MHz

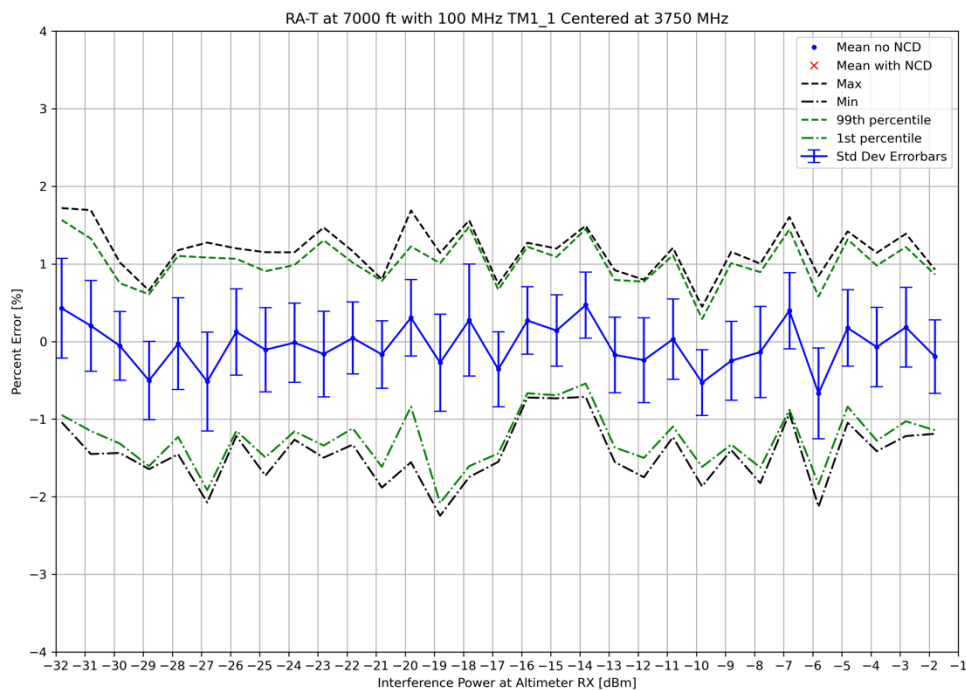


Figure 3-92: UC1 RA-T 7000' AGL Statistics with TM1.1 at 3750 MHz

Center Frequency = 3850 MHz

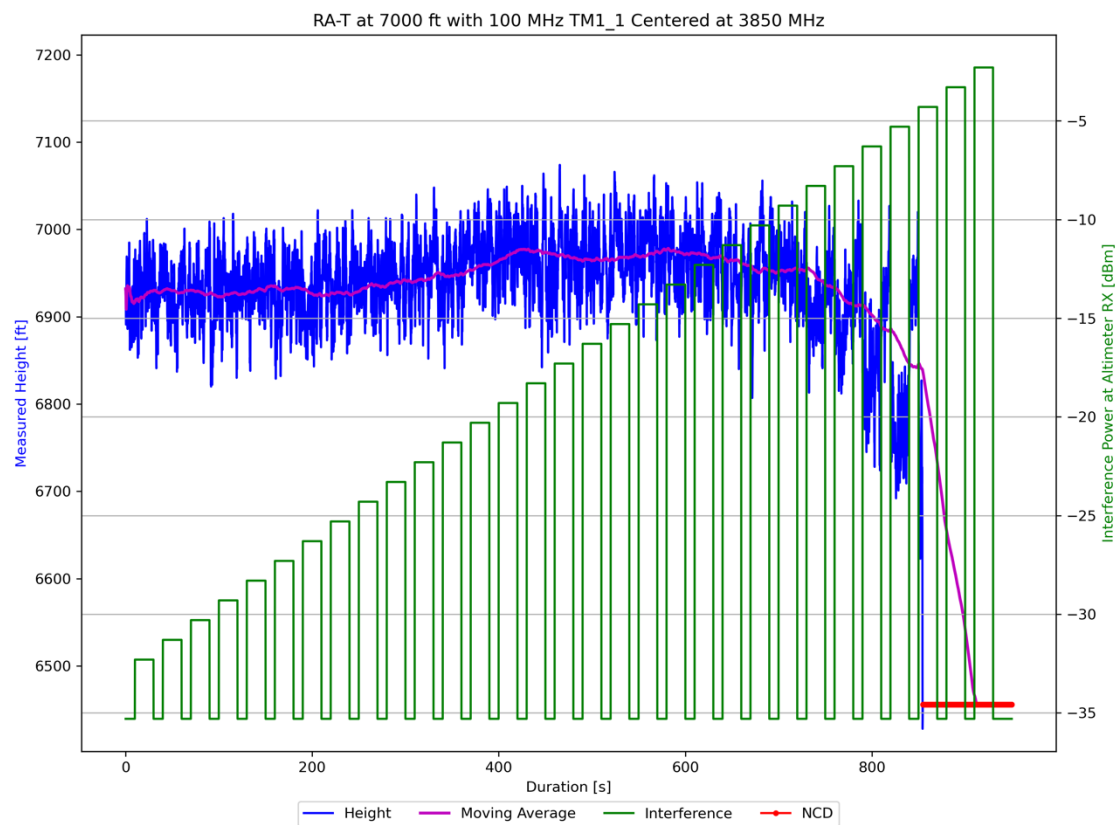


Figure 3-93: UC1 RA-T 7000' AGL Time History with TM1.1 at 3850 MHz

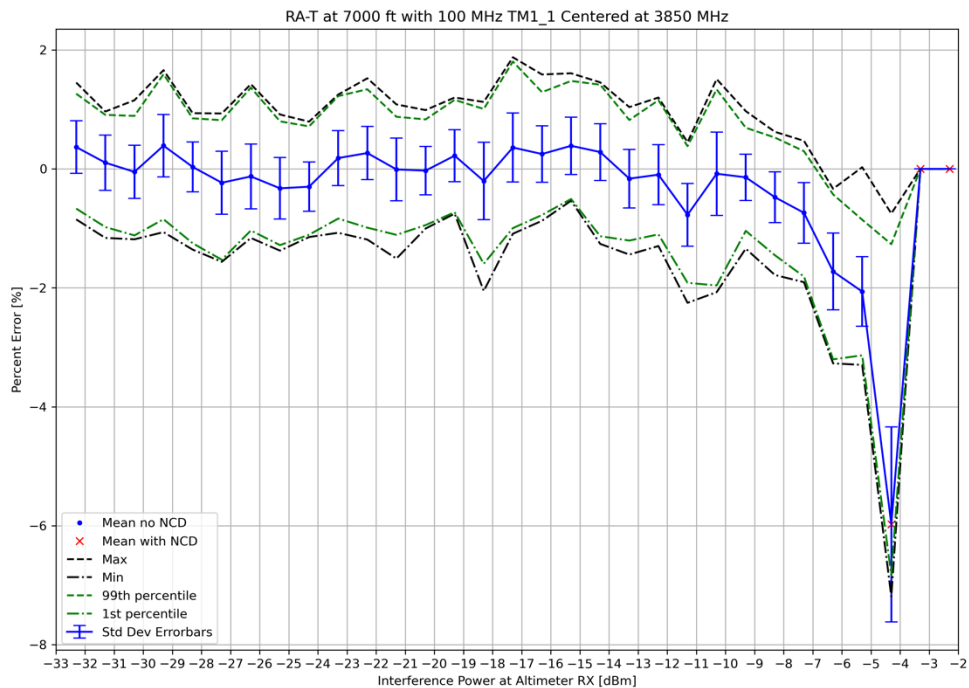


Figure 3-94: UC1 RA-T 7000' AGL Statistics with TM1.1 at 3850 MHz – Zoomed Out

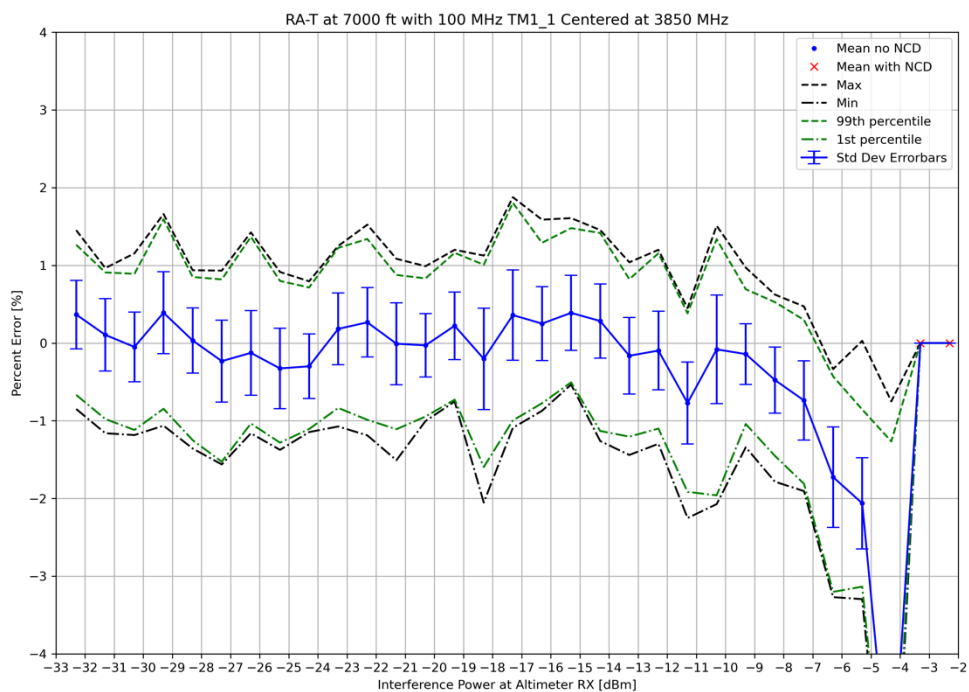


Figure 3-95: UC1 RA-T 7000' AGL Statistics with TM1.1 at 3850 MHz – Zoomed In

Center Frequency = 3930 MHz

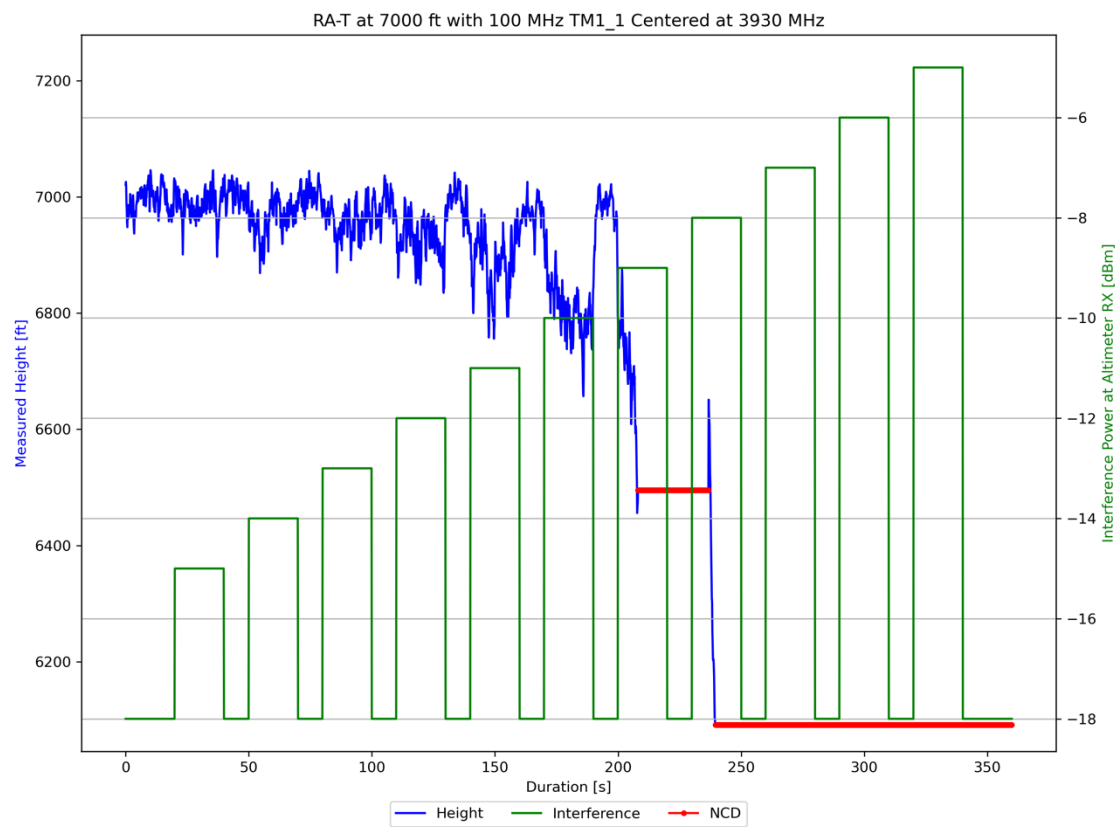


Figure 3-96: UC1 RA-T 7000' AGL Time History with TM1.1 at 3930 MHz

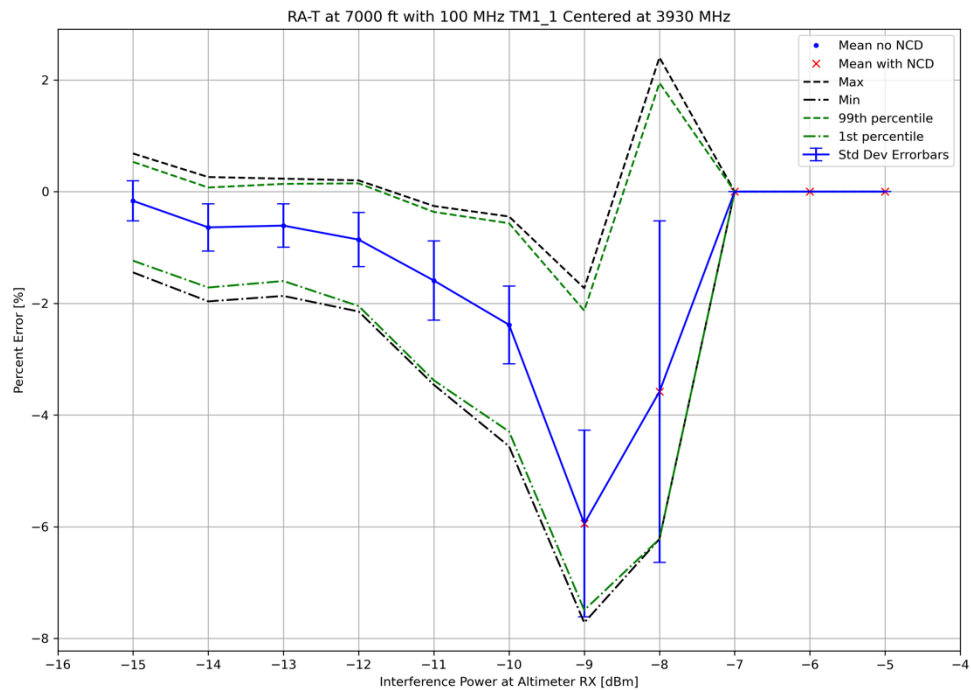


Figure 3-97: UC1 RA-T 7000' AGL Statistics with TM1.1 at 3930 MHz – Zoomed Out

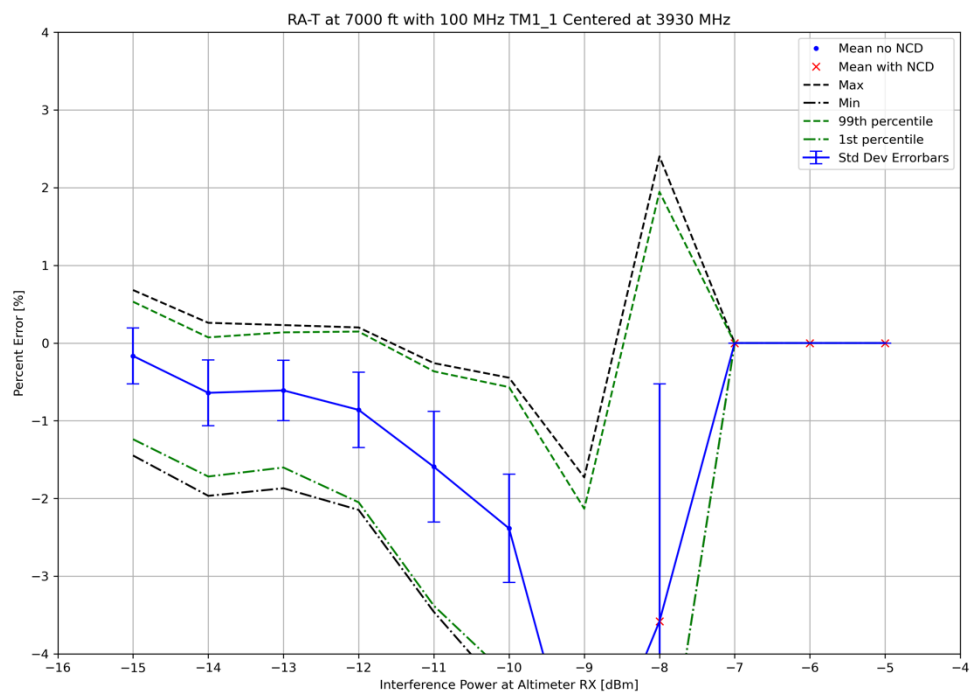


Figure 3-98: UC1 RA-T 7000' AGL Statistics with TM1.1 at 3930 MHz – Zoomed In

### 3.2.3.5 Altimeter X

Table 3-21: UC1 RA-X 5000' AGL OOB Fundamental Emissions Break Point Summary

Center Frequency	Plot	Comments
<b>3750 MHz</b>	Time History Figure 3-99	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-100 Figure 3-101	Mean error exceeds the $\pm 0.5\%$ criterion threshold near -11 dBm. 1 <sup>st</sup> percentile measured height is less than the -2% criterion threshold near -10 dBm. An NCD occurs near -7 dBm.
<b>3850 MHz</b>	Time History Figure 3-102	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-103 Figure 3-104	Mean error exceeds the $\pm 0.5\%$ criterion threshold near -26 dBm. 1 <sup>st</sup> percentile measured height is less than the -2% criterion threshold at -16 dBm. An NCD occurs near -14 dBm.
<b>3930 MHz</b>	Time History Figure 3-105	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-106 Figure 3-107	Mean error exceeds the $\pm 0.5\%$ criterion threshold at -24 dBm. 1 <sup>st</sup> percentile measured height is less than the -2% criterion threshold at -23 dBm. An NCD occurs at -20 dBm.



Center Frequency = 3750 MHz

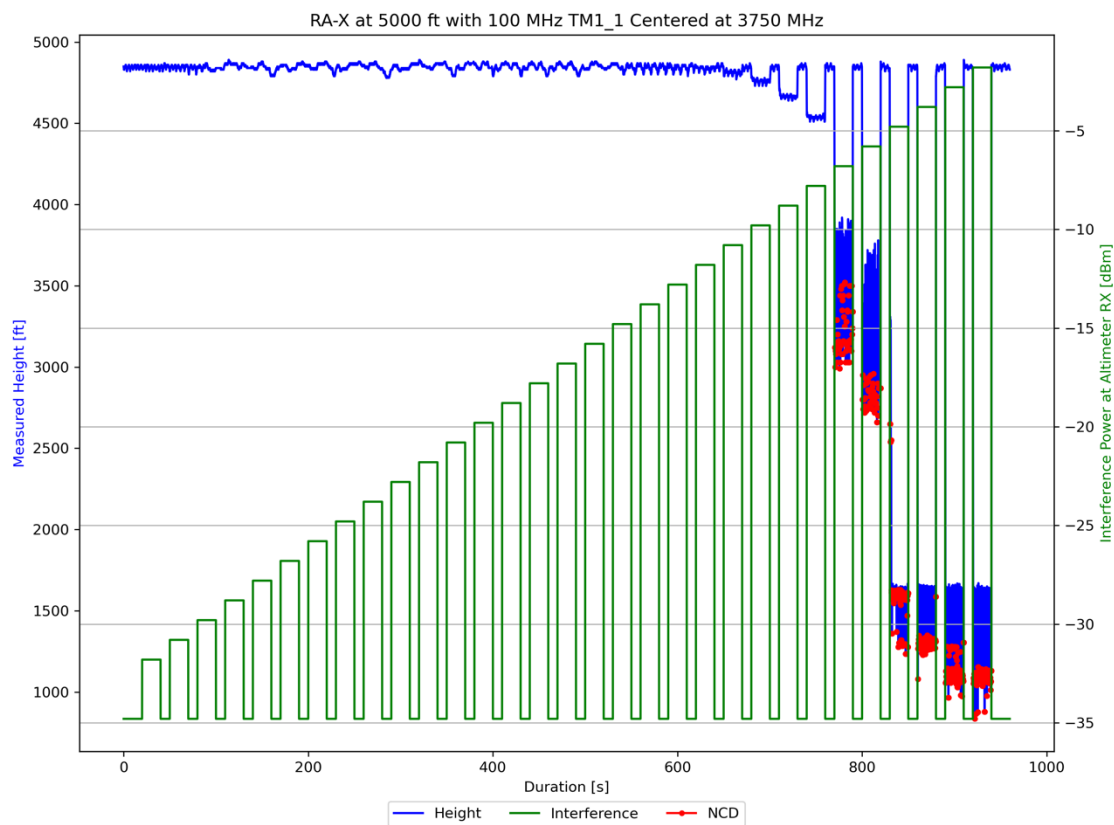


Figure 3-99: UC1 RA-X 5000' AGL Time History with TM1.1 at 3750 MHz

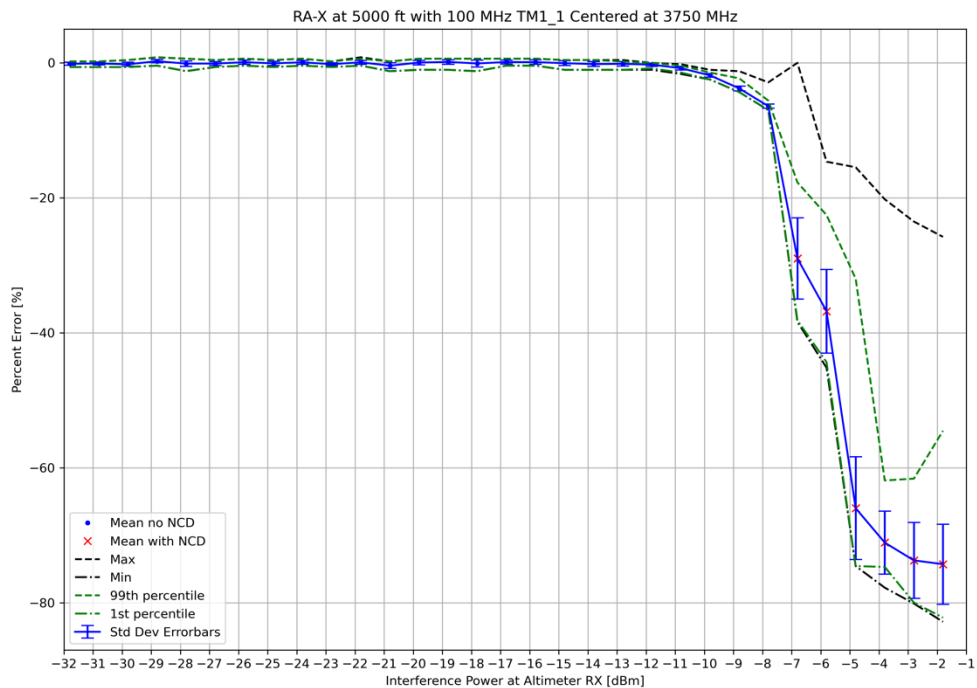


Figure 3-100: UC1 RA-X 5000' AGL Statistics with TM1.1 at 3750 MHz – Zoomed Out

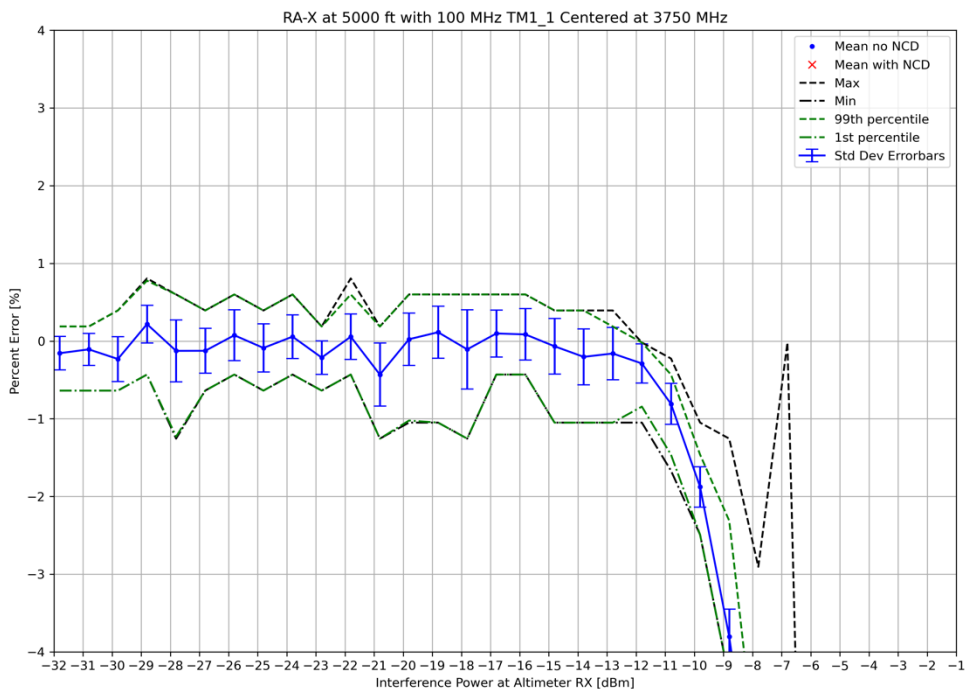


Figure 3-101: UC1 RA-X 5000' AGL Statistics with TM1.1 at 3750 MHz – Zoomed In

Center Frequency = 3850 MHz

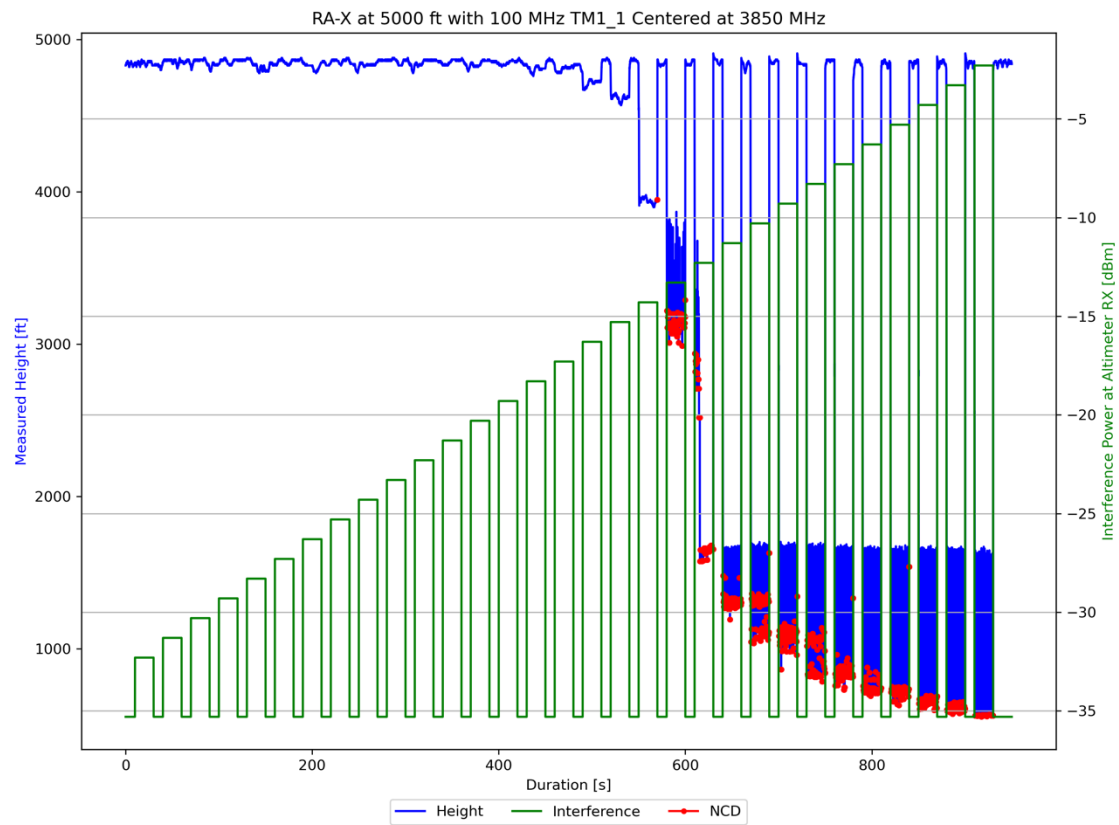


Figure 3-102: UC1 RA-X 5000' AGL Time History with TM1.1 at 3850 MHz

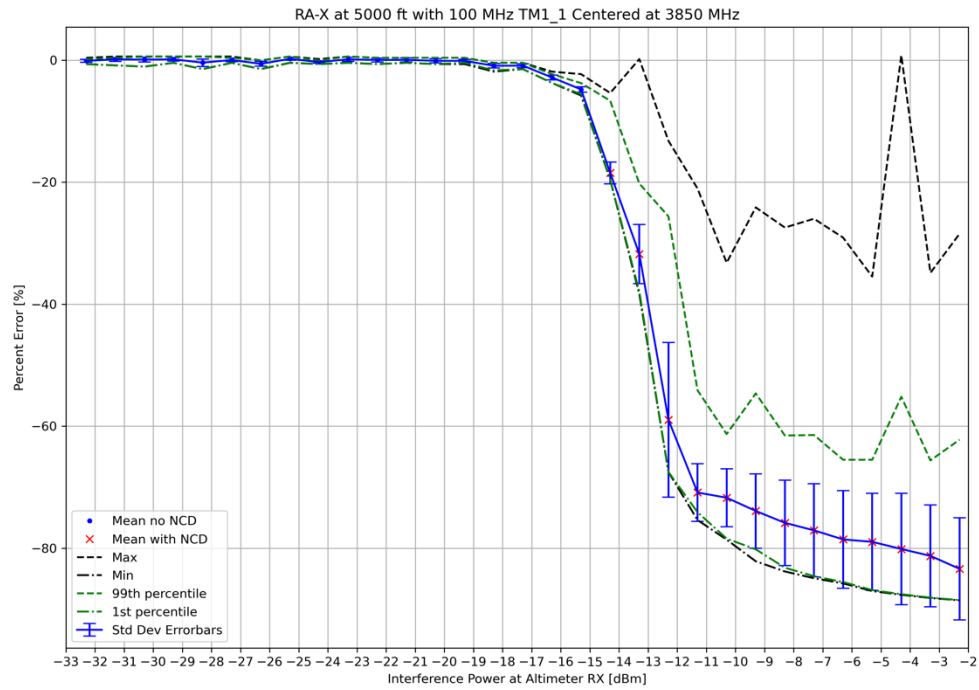


Figure 3-103: UC1 RA-X 5000' AGL Statistics with TM1.1 at 3850 MHz – Zoomed Out

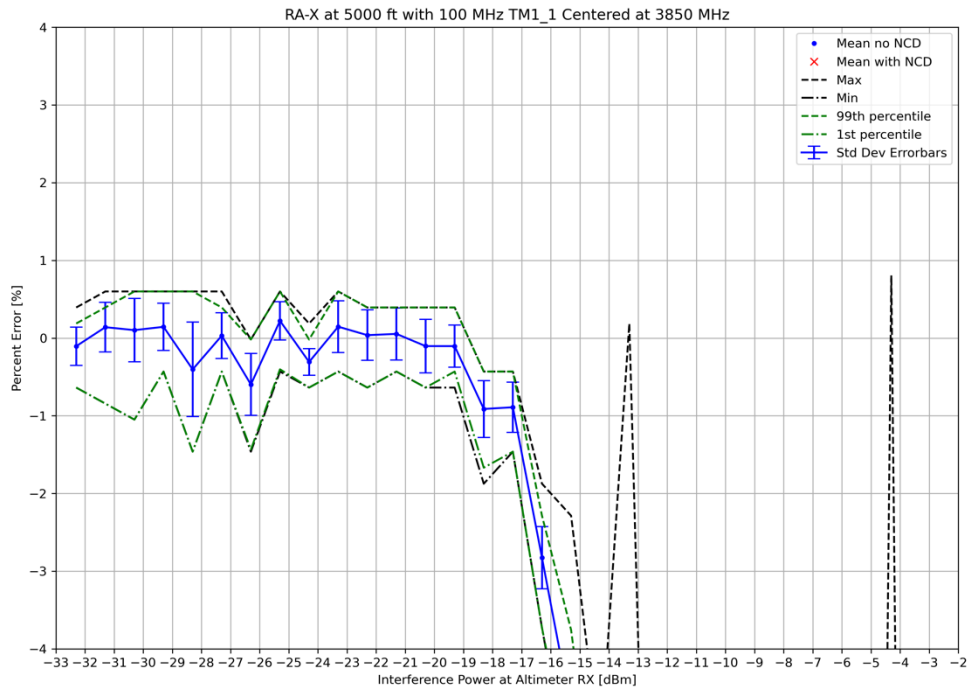


Figure 3-104: UC1 RA-X 5000' AGL Statistics with TM1.1 at 3850 MHz – Zoomed In

Center Frequency = 3930 MHz

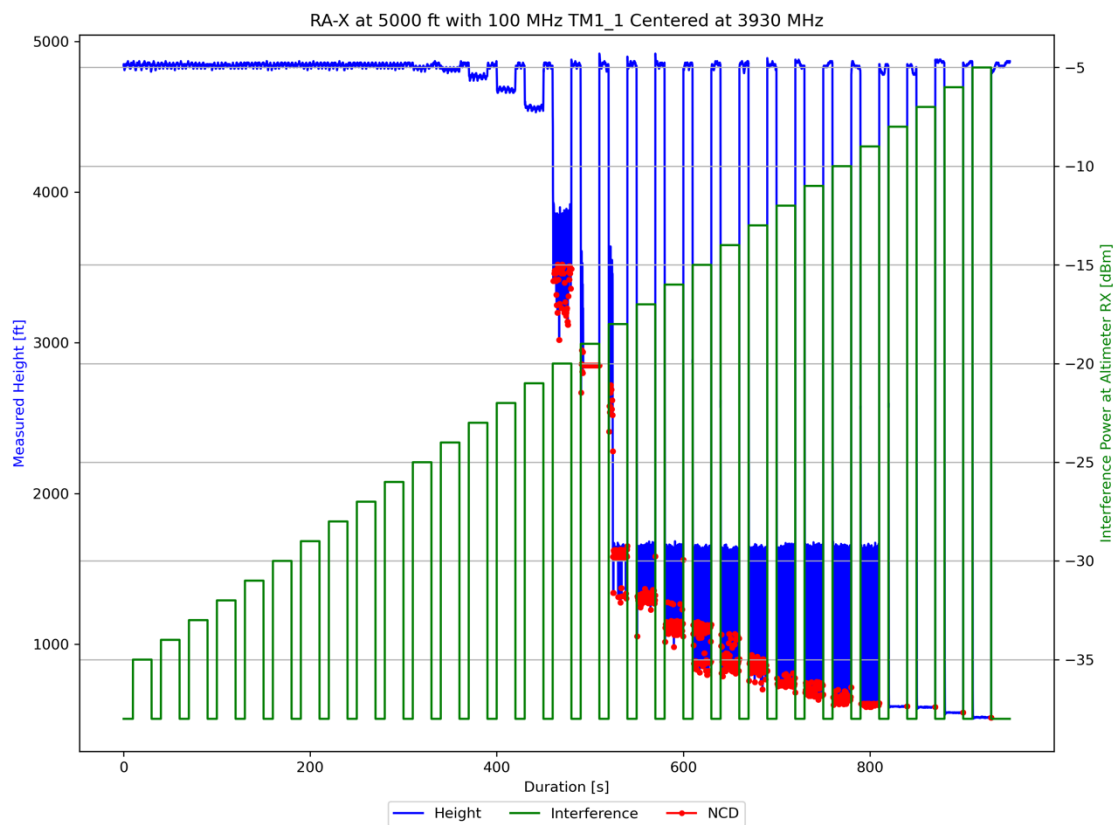


Figure 3-105: UC1 RA-X 5000' AGL Time History with TM1.1 at 3930 MHz

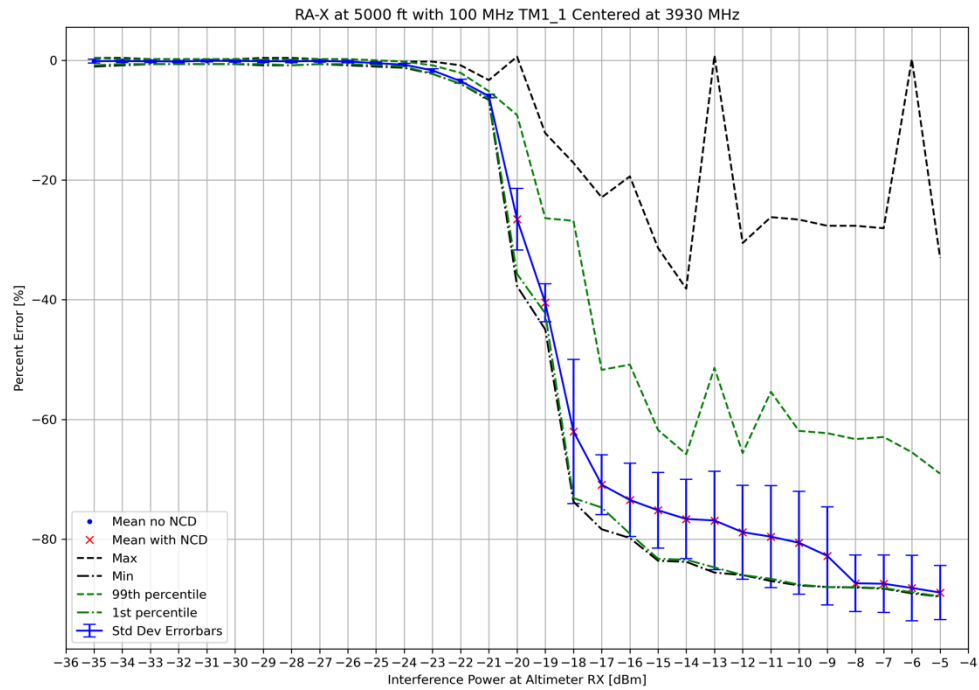


Figure 3-106: UC1 RA-X 5000' AGL Statistics with TM1.1 at 3930 MHz – Zoomed Out

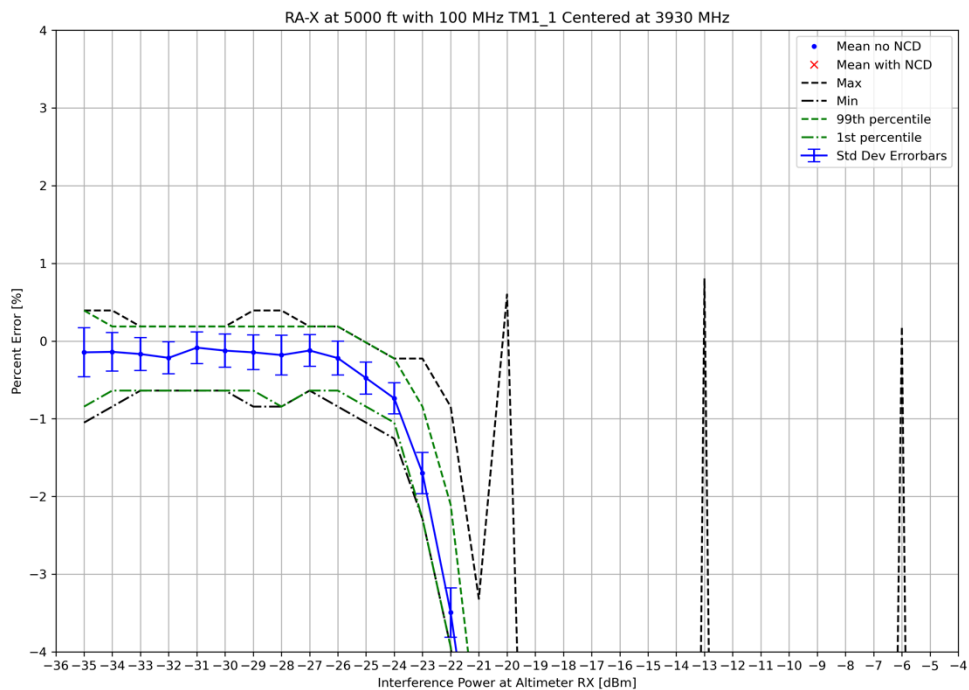


Figure 3-107: UC1 RA-X 5000' AGL Statistics with TM1.1 at 3930 MHz – Zoomed In

### 3.2.3.6 Altimeter Y

Table 3-22: UC1 RA-Y 5000' AGL OOB Fundamental Emissions Break Point Summary

Center Frequency	Plot	Comments
<b>3750 MHz</b>	Time History Figure 3-108	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-109 Figure 3-110	An NCD occurs near -25 dBm. Mean error exceeds the $\pm 0.5\%$ criterion threshold near -23 dBm. 1 <sup>st</sup> percentile measured height is less than the -2% criterion threshold near -23 dBm.
<b>3850 MHz</b>	Time History Figure 3-111	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-112 Figure 3-113	An NCD occurs near -25 dBm. Mean error exceeds the $\pm 0.5\%$ criterion threshold near -24 dBm. 1 <sup>st</sup> percentile measured height is less than the -2% criterion threshold near -19 dBm.
<b>3930 MHz</b>	Time History Figure 3-114	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-115 Figure 3-116	An NCD occurs at -26 dBm. Mean error exceeds the $\pm 0.5\%$ criterion threshold at -25 dBm. 1 <sup>st</sup> percentile measured height is less than the -2% criterion threshold at -25 dBm.

Center Frequency = 3750 MHz

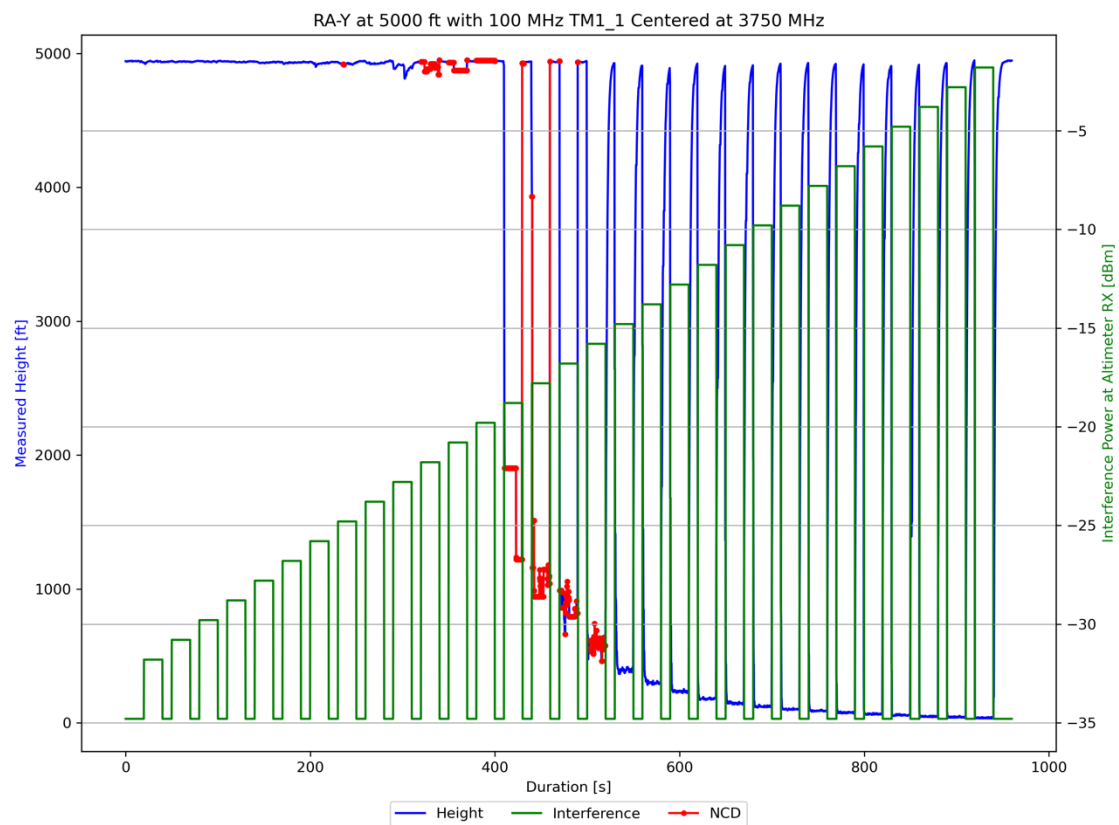


Figure 3-108: UC1 RA-Y 5000' AGL Time History with TM1.1 at 3750 MHz



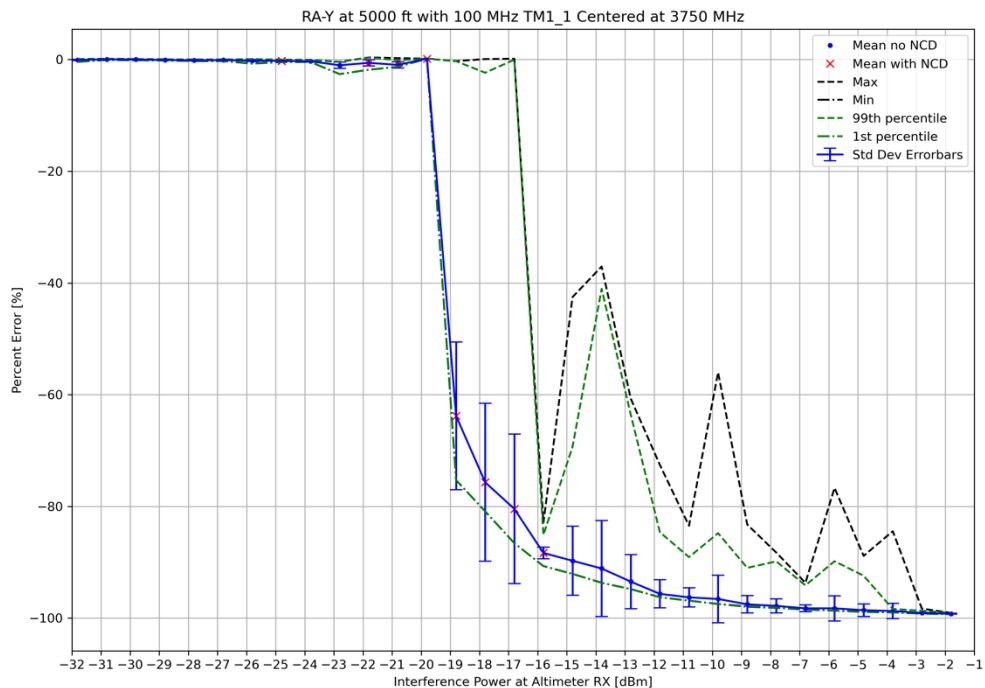


Figure 3-109: UC1 RA-Y 5000' AGL Statistics with TM1.1 at 3750 MHz – Zoomed Out

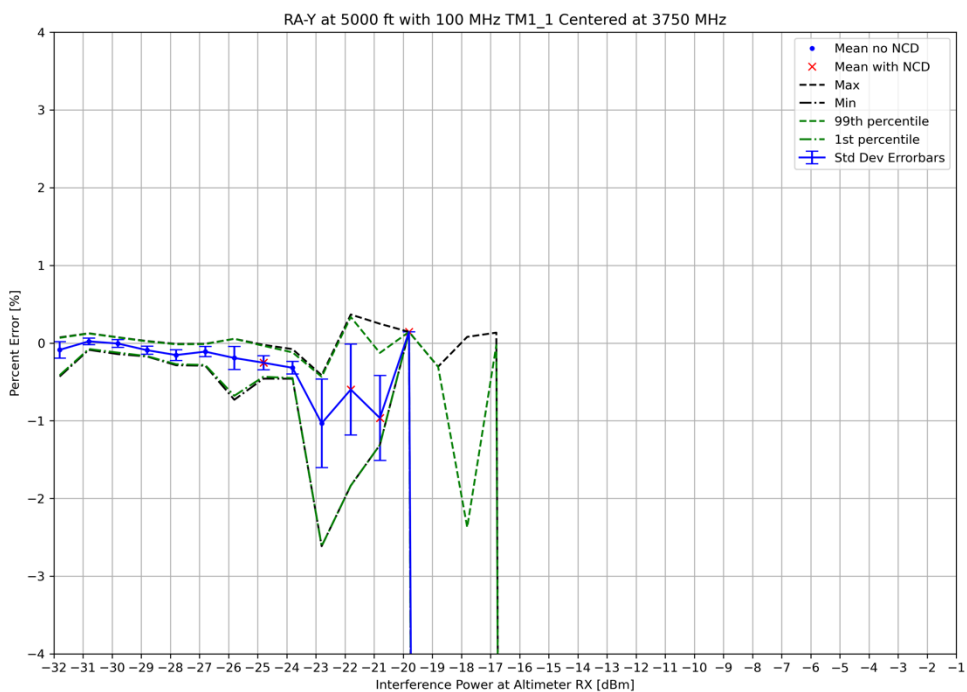


Figure 3-110: UC1 RA-Y 5000' AGL Statistics with TM1.1 at 3750 MHz – Zoomed In

Center Frequency = 3850 MHz

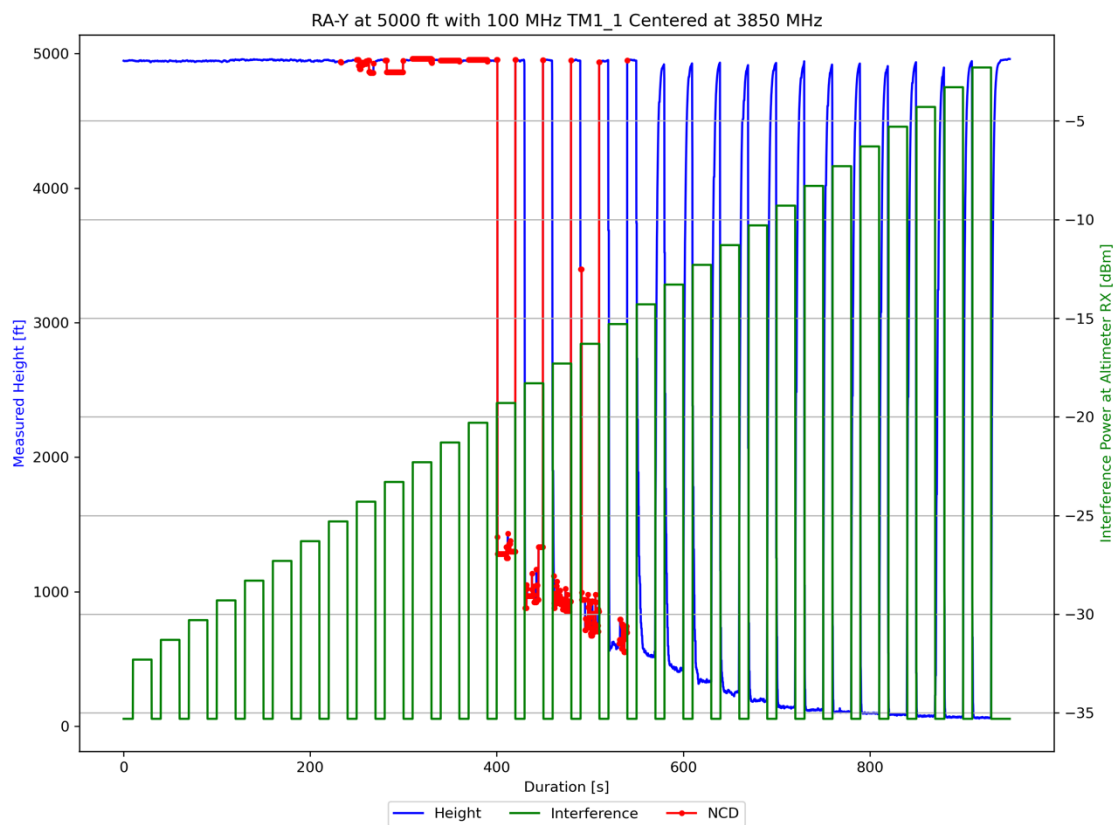


Figure 3-111: UC1 RA-Y 5000' AGL Time History with TM1.1 at 3850 MHz

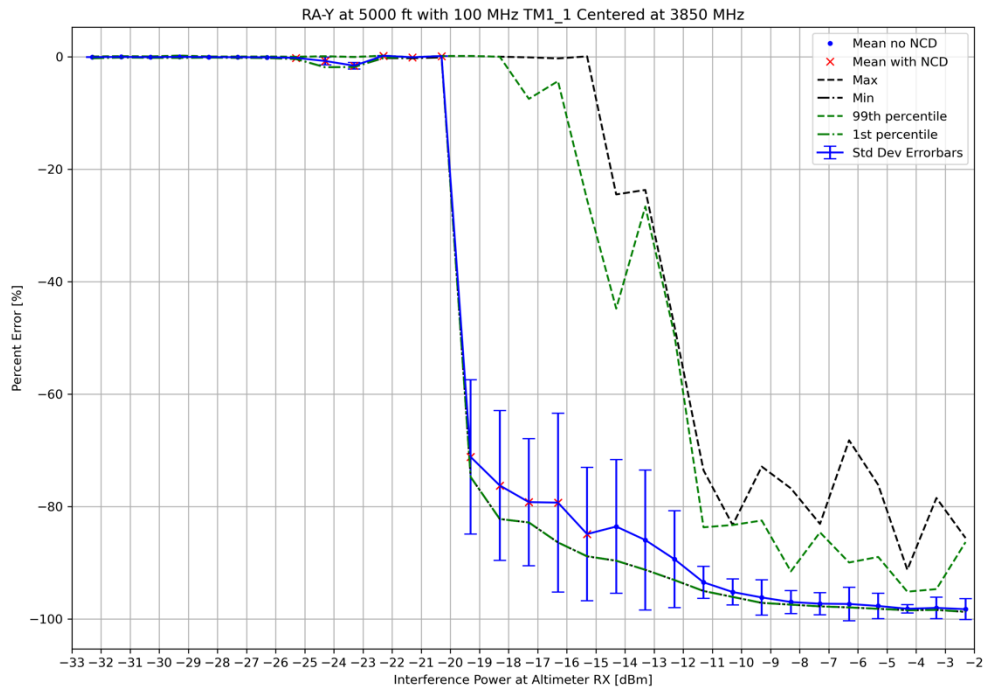


Figure 3-112: UC1 RA-Y 5000' AGL Statistics with TM1.1 at 3850 MHz – Zoomed Out

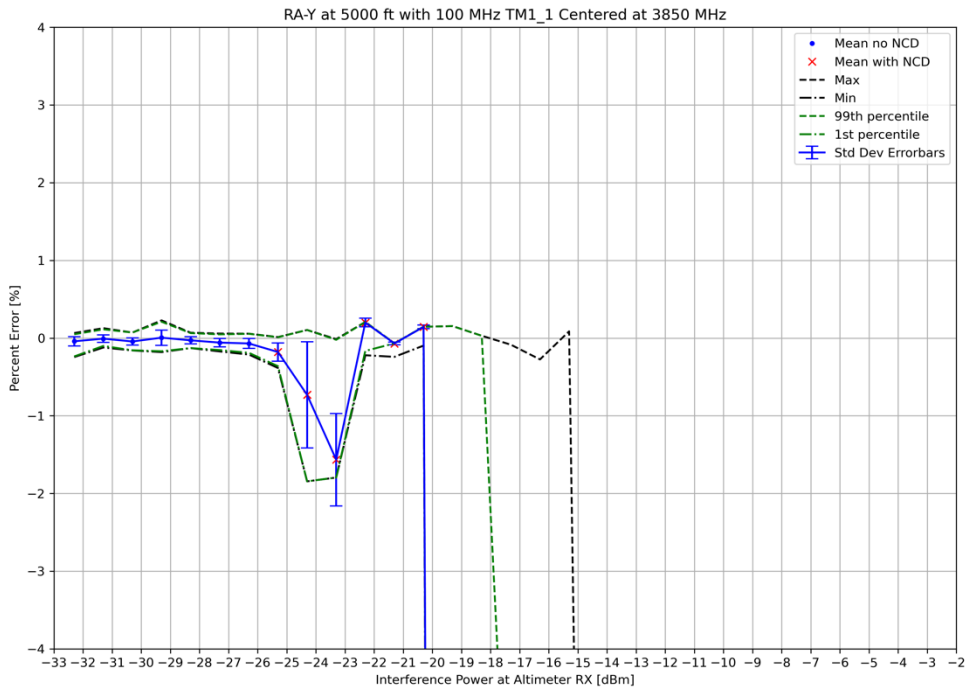


Figure 3-113: UC1 RA-Y 5000' AGL Statistics with TM1.1 at 3850 MHz – Zoomed In

Center Frequency = 3930 MHz

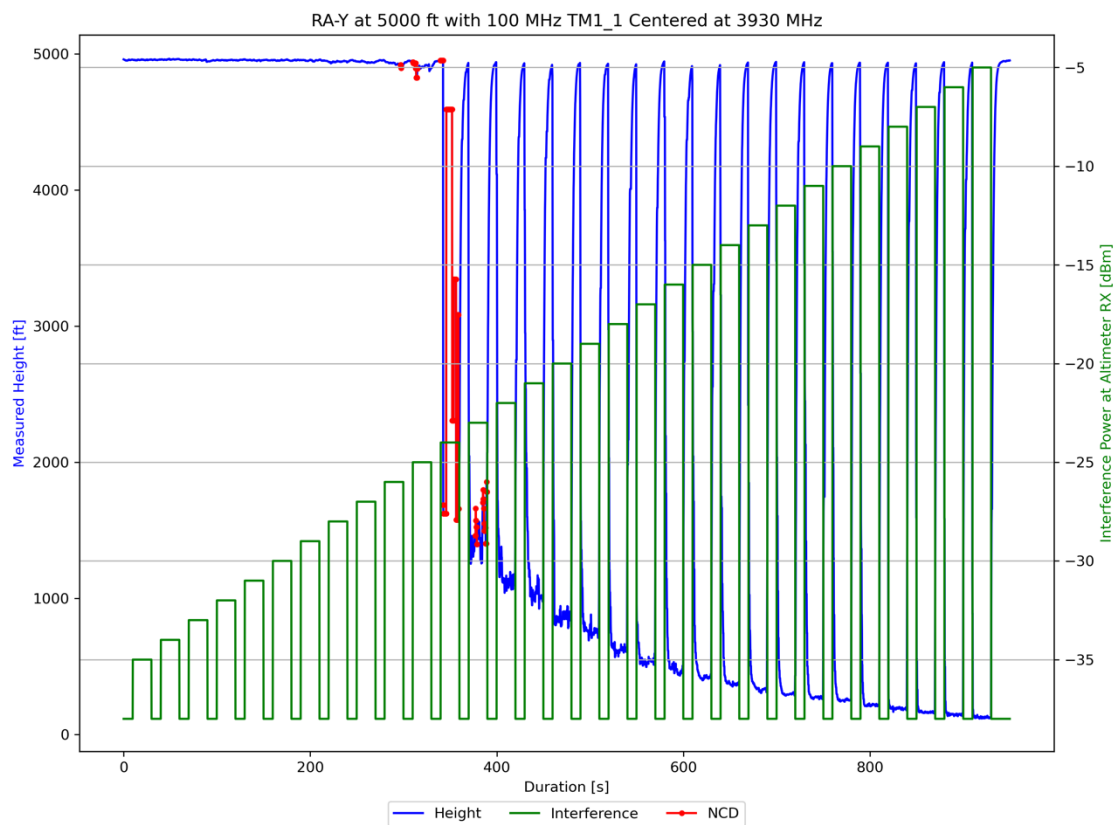


Figure 3-114: UC1 RA-Y 5000' AGL Time History with TM1.1 at 3930 MHz

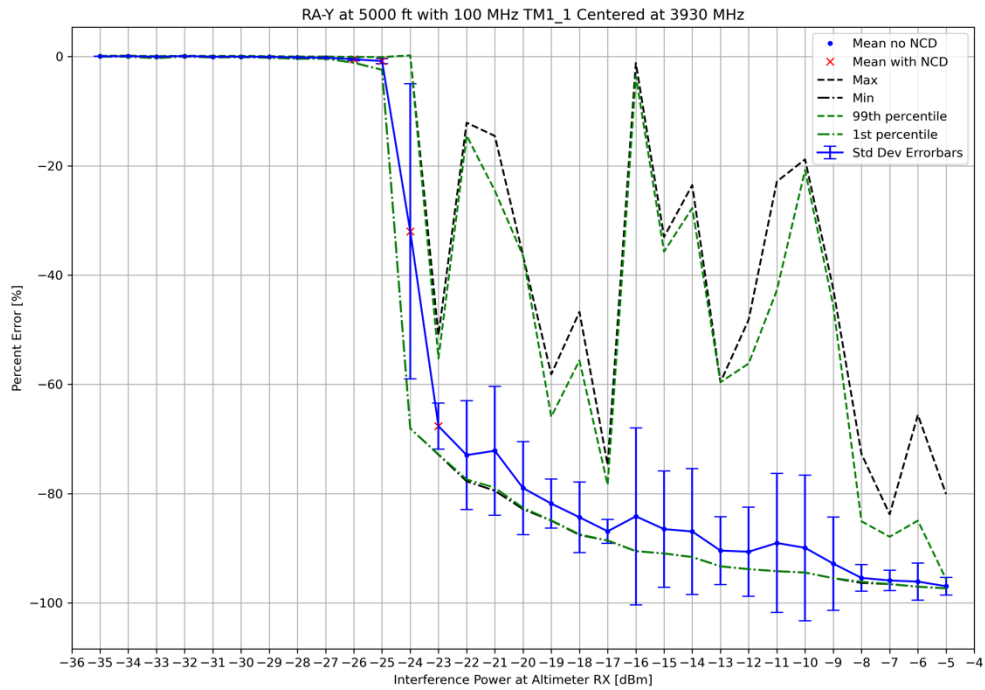


Figure 3-115: UC1 RA-Y 5000' AGL Statistics with TM1.1 at 3930 MHz – Zoomed Out

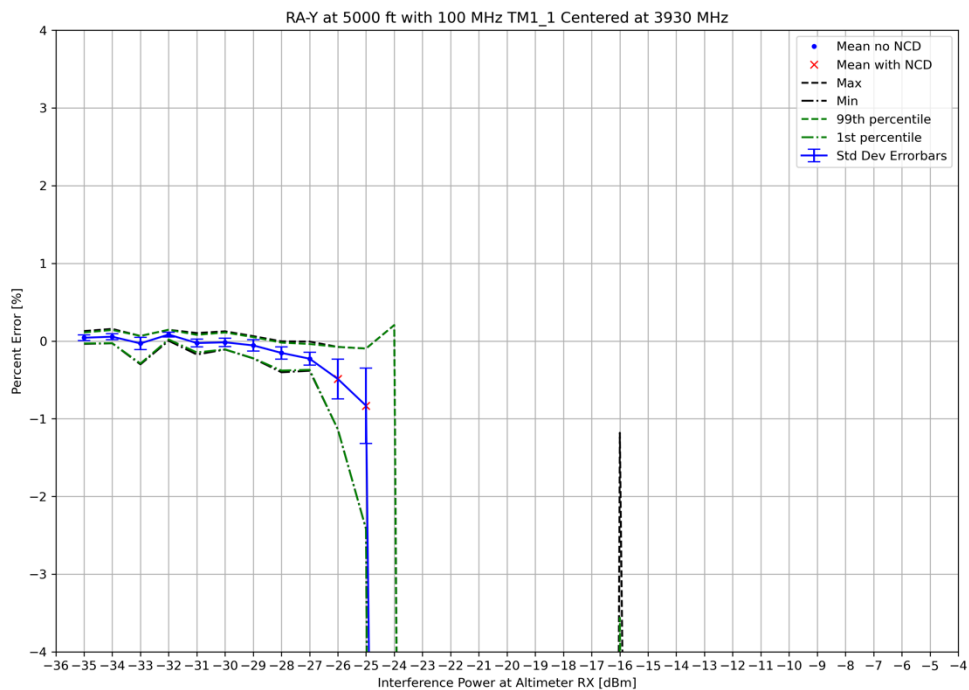


Figure 3-116: UC1 RA-Y 5000' AGL Statistics with TM1.1 at 3930 MHz – Zoomed In